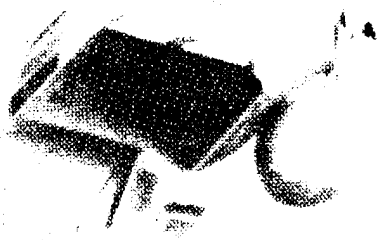
Naval Aerospace Medical Research Laboratory

NAMRL Technical Memorandum 95-1

SOUND ATTENUATION EVALUATION OF THE NAVY'S HGU-84/P HELICOPTER HELMET

D. W. Maxwell and C. E. Williams



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Reviewed and approved 12 Jan 95

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This research was sponsored by the Naval Warfare Center, Aircraft Division, Warminster, PA, under Work Request N62269/94/WR00136.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

Volunteer subjects were recruited, evaluated, and employed in accordance with the procedures specified in the Department of Defense Directive 3216.2 and Secretary of the Navy Instruction 3900.39 series. These instructions are based upon voluntary informed consent and meet or exceed the provisions of prevailing national and international guidelines.

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ABSTRACT

"First article" sound attenuation tests were conducted on samples of the HGU-84/P helicopter helmet, candidate replacement for the SPH-3C series of helmets, supplied for evaluation by the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania. The tests were conducted in accordance with American National Standard ANSI S12.6-1984, "Method for the Measurement of Real-Ear Attenuation of Hearing Protectors." Objective measurements of attenuation, microphone-in-real-ear (MIRE), were also obtained. Ten Marine Corps student aviators served as volunteer test subjects. Real-ear attenuation values calculated from measurements made at the nine, one-third octave test frequencies met or exceeded the required minimum real-ear attenuation specifications for the newly developed helmet. This technical memorandum documents the results of the sound attenuation tests. The HGU-84/P helmet is currently being fielded as a replacement for the SPH-3C helmet.

INTRODUCTION

At the request of the Naval Air Systems Command and the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania (1), "first article" sound attenuation tests were conducted on samples of the Navy's candidate replacement helmet for the SPH-3C series of helmets--the HGU-84/P. The tests were conducted to determine if the newly developed helmet met the required minimum real-ear attenuation specifications. Photographs of one of the sample helmets supplied for testing can be seen in Figs. 1 (visor up), 2 (visor down), and 3 (visor covered). While only real-ear attenuation test data were requested and required, we also obtained objective measurements of attenuation (microphone-in-real-ear or MIRE) for database and record purposes. This technical memorandum documents the results of the sound attenuation tests.

METHODS

Subjects. Ten Marine Corps student aviators in the Naval Aviation Flight Training Program served as volunteer test subjects for both the requested real-ear attenuation tests and the objective real-ear attenuation (MIRE) tests. All of the subjects had hearing threshold levels of 20 dB or less at the standard audiometric test frequencies.

Real-ear attenuation tests. The real-ear attenuation tests were conducted in NAMRL's Real Ear Attenuation Test Facility in accordance with American National Standard S12.6-1984 (2). Figure 4 shows one of the test subjects responding to auditory test signals (one-third octave bands of noise centered at each of the nine test frequencies) in the Real Ear Attenuation Test Facility.

Objective real-ear attenuation. The MIRE measurements were obtained in a semireverberant test chamber. A Knowles miniature microphone was placed at the outer end of a Silaflex earplug that was inserted into the subject's right ear. The wire to the microphone was small enough so as not to interfere with the seal of the helmet earcups, and the microphone and wire were secured so that the microphone remained fixed as the helmet was donned and doffed. Figure 5 shows one of the test subjects in the semireverberant test chamber with the miniature microphone inserted in his right ear.

Procedure (MIRE measurements). A one-third octave band analysis of the microphone's output was first obtained without the helmet being worn as the subject was seated in a broadband noise environment (108 dB SPL). Following free-field (i.e., unattenuated) measurements, the subject donned the helmet, and one-third octave band analyses were obtained with the helmet on (attenuated measurements). The procedure was repeated three times, and the helmet was donned and doffed on each occasion.

Real-ear and MIRE measurements obtained with the helmet on were subtracted from the unattenuated (free-field) measurements to determine the amount of attenuation afforded by the helmet. Means and standard deviations were calculated from the various measurements.

RESULTS

Mean sound-attenuation values and standard deviations obtained via the real-ear attenuation measurements are shown in Table 1, together with the minimum acceptable real-ear attenuation values specified in the requirements for the new helmet. A graphic comparison of the "obtained" versus "required" real-ear attenuation values is shown in Fig. 6. Mean attenuation values, standard deviations, and noise-reduction ratings calculated from both the real-ear and objective real-ear attenuation measurements (MIRE) are shown together with individual subject data in Appendices A and B. A graphic comparison of the attenuation values obtained via the two types of measurements (real-ear and MIRE) is shown in Fig. 7. The MIRE values are shown for database and record purposes. It should be noted that subsequent to obtaining

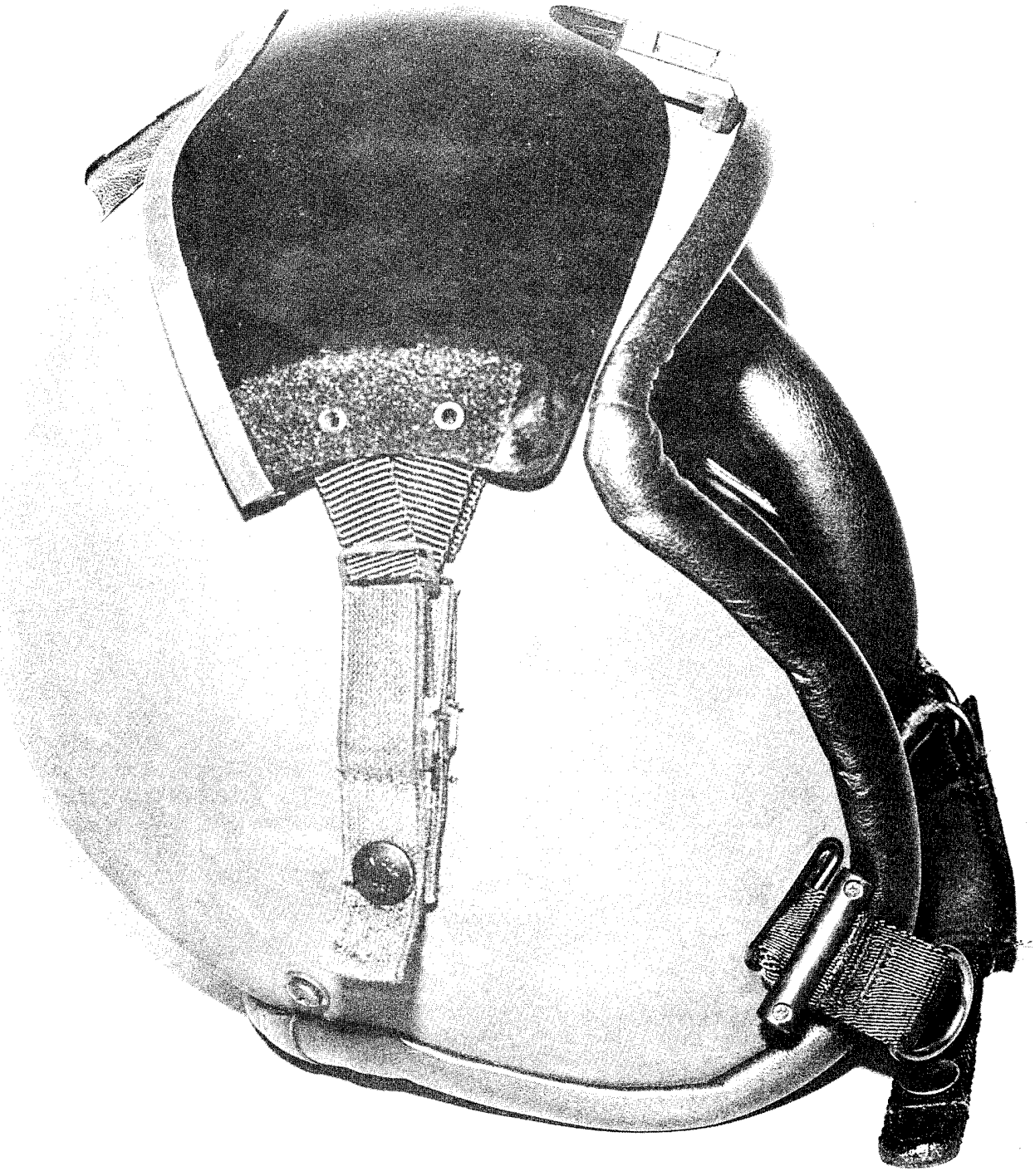

Figure 1. Side-view-of HGU-84/P helmet (visor up).

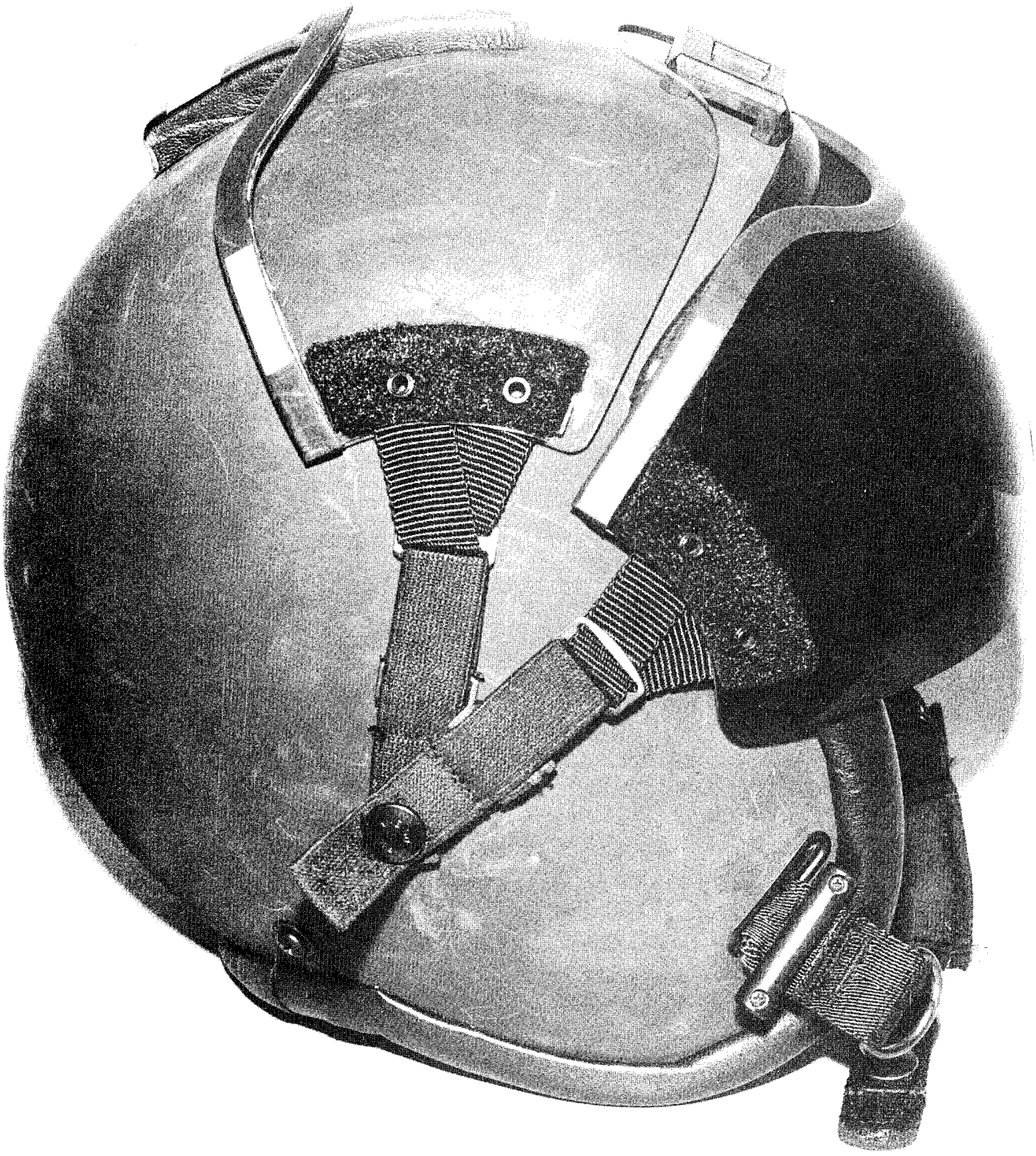

Figure 2. Side-view of HGU-84/P helmet (visor down).

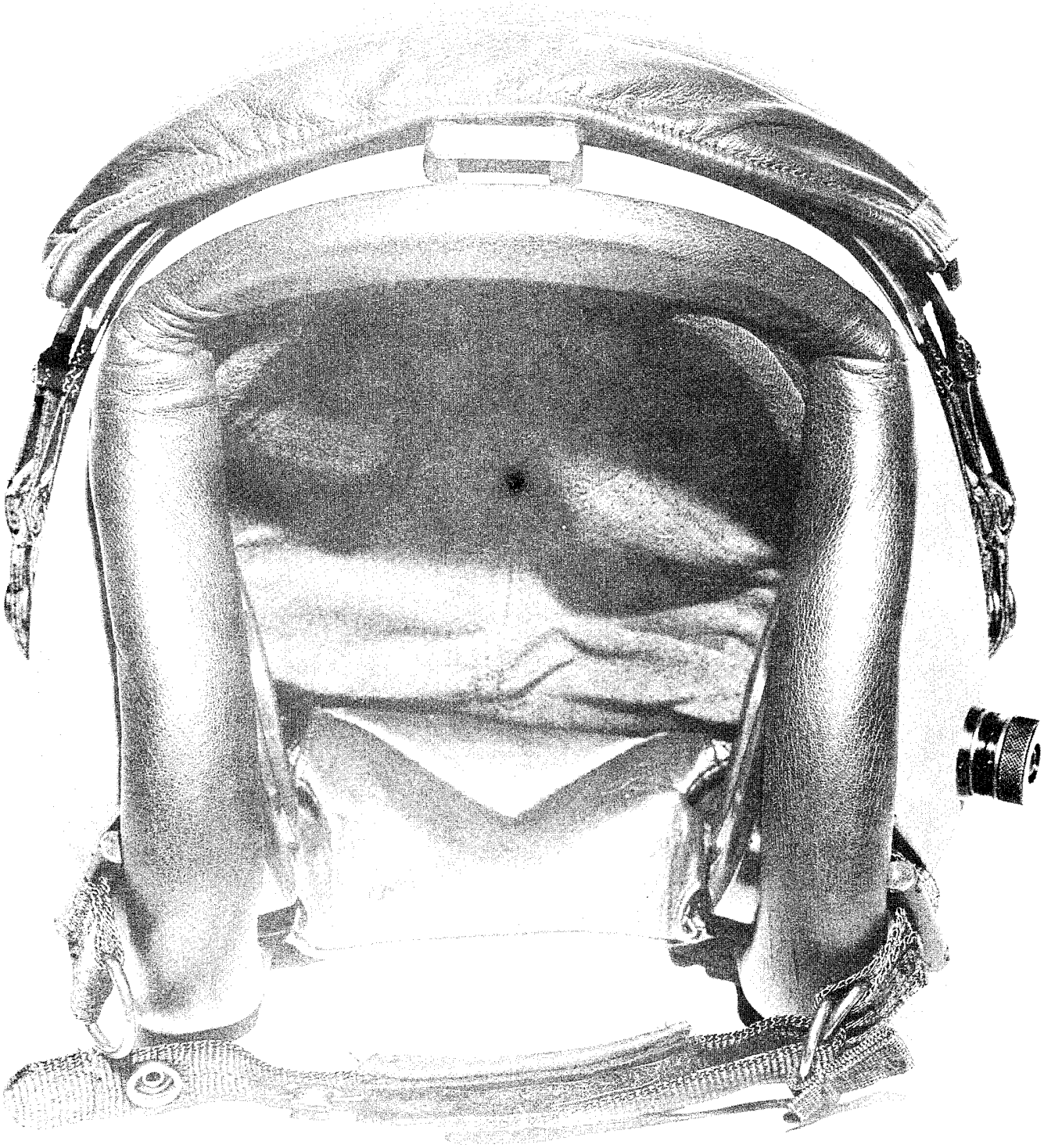

Figure 3. Front view of HGU-84/P helmet (visor covered).

Figure 4. Test subject responding to auditory test signals in Real Ear Attenuation Test Facility.

Figure 5. Test subject with miniature microphone inserted in right ear.

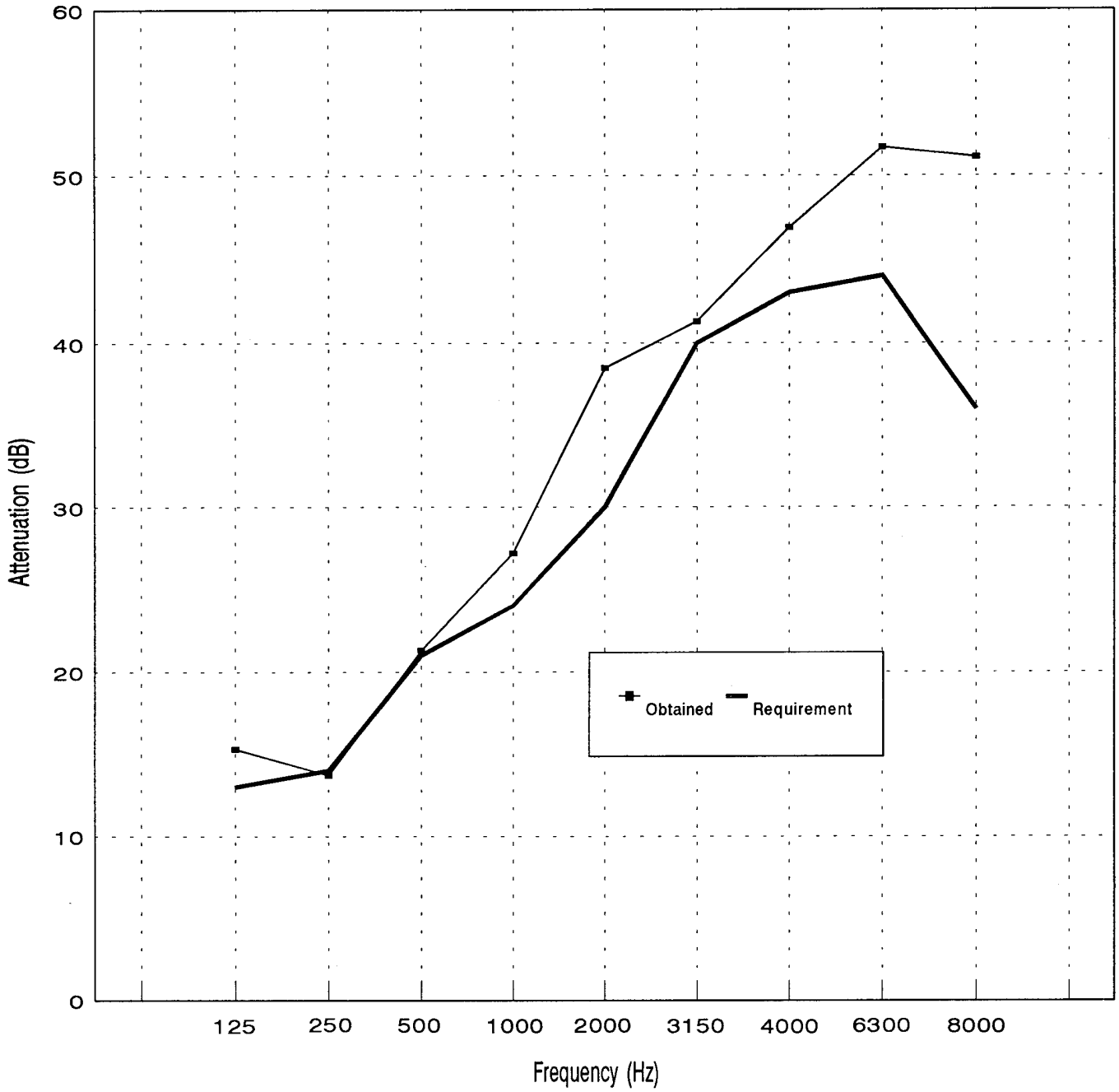

Figure 6. Graphic comparison of real-ear attenuation values obtained with the HGU-84/P helmet and the minimum acceptable attenuation values specified in the requirement.

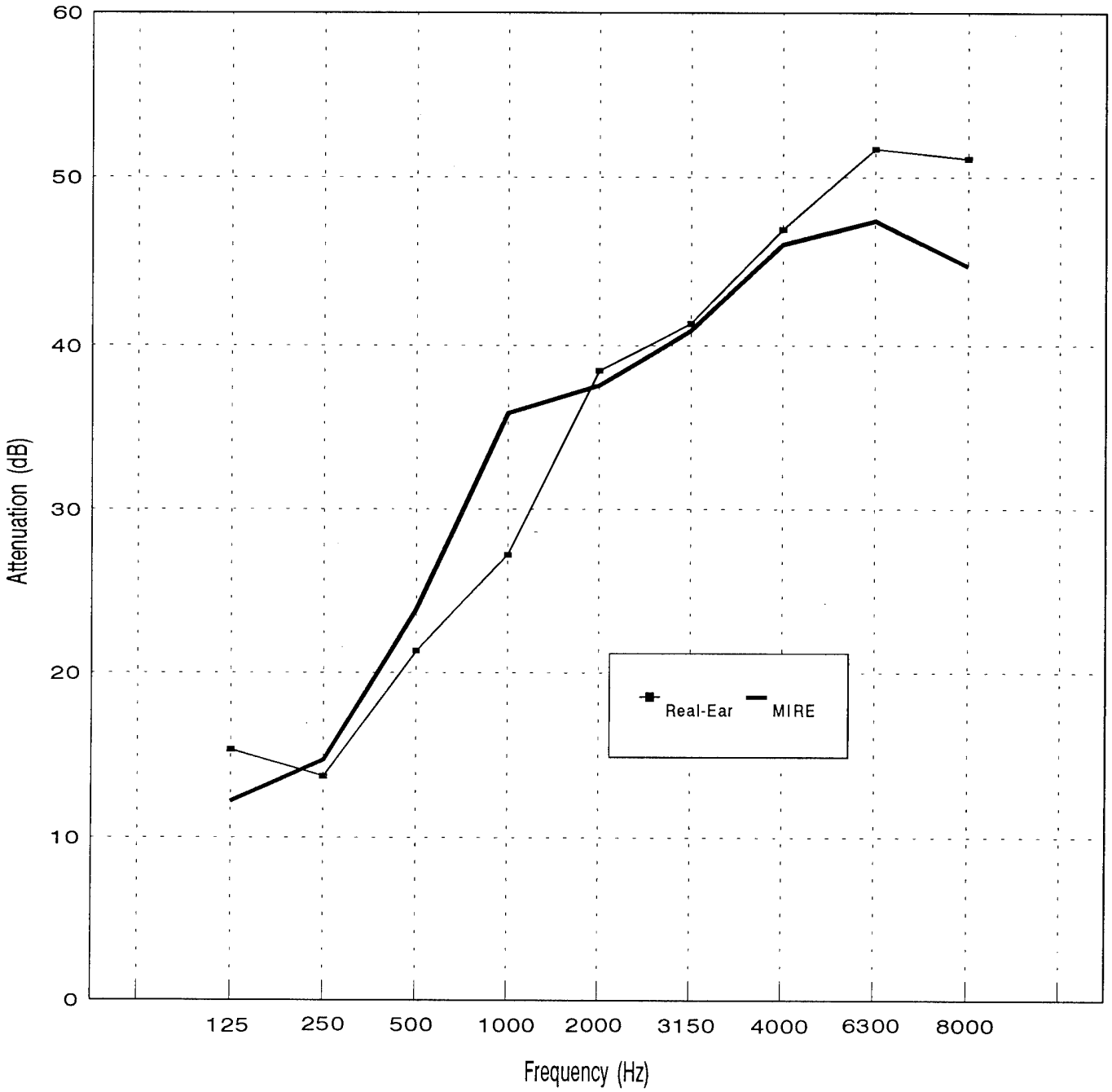

Figure 7. Graphic comparison of real-ear attenuation values and microphone-in-real-ear (MIRE) attenuation values obtained with the HGU-84/P helmet.

and reporting the attenuation measurements just described, additional MIRE attenuation measurements were obtained on 10 additional flight students (right and left ears). The results of these MIRE measurements are shown in Appendix C.

Table 1. Mean real-ear attenuation values and standard deviations (in dB). Minimum required attenuation values are shown for comparison.

	One-third octave band center frequency (Hz)								
	125	250	500	1000	2000	3150	4000	6300	8000
Obtained									
Mean	15.3	13.7	21.3	27.2	38.5	41.3	46.9	51.7	51.1
S.D.	3.6	3.5	2.7	4.7	6.2	6.0	5.2	6.7	6.3
Minimum required									
Mean	13.0	14.0	21.0	24.0	30.0	40.0	43.0	44.0	36.0

As can be seen in Table 1 and Fig. 5, real-ear attenuation values calculated from measurements made at the nine, one-third octave test frequencies (125, 250, 500, 1000, 2000, 3150, 4000, 6300, and 8000 Hz) met or exceeded the minimum required real-ear attenuation specifications for the new helmet.

CONCLUSIONS

The results of the real-ear attenuation evaluation demonstrated that the HGU-84/P helmet met or exceeded the minimum required real-ear attenuation specifications. The real-ear attenuation test data, in conjunction with the results of other first article tests conducted elsewhere, were instrumental in a subsequent Navy recommendation to implement fielding of the HGU-84/P helmet as a replacement for the SPH-3C series of helmets. Field implementation of the new helmet is currently underway.

REFERENCES

1. Work Request N62269/94/WR00136, Naval Air Warfare Center Aircraft Division, Warminster, PA, February 1994.

2. American National Standards Institute, American National Standard ANSI S12.6-1984, Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors, 1984.

PROTECTOR: HGU-84/P "REAL-EAR" DATES: 02/01/94 / 02/09/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 22	16	14	26	24	36	36	44	52	54
K.G.	14	16	22	24	36	34	40	50	48
"L" 1	16	14	18	20	36	40	46	48	48
M - 27	12	14	22	22	30	36	46	48	48
M.W.	16	18	30	20	26	32	44	44	48
"L" 2	8	16	22	20	30	32	40	42	46
M - 23	10	12	20	26	32	44	46	52	40
C.B.	16	14	20	26	30	36	40	52	52
"L" 3	16	18	18	28	36	40	42	50	50
M - 22	14	12	20	22	34	40	42	48	46
M.D.	16	6	18	24	28	34	40	48	50
"XL" 4	10	18	24	24	36	36	40	46	48
M - 23	22	20	24	30	40	40	44	56	62
S.Q.	24	20	18	28	42	40	46	60	58
"XL" 5	16	14	22	30	46	38	48	56	62
M - 24	12	10	24	38	44	48	52	62	54
J.P.	16	10	20	36	44	50	56	58	58
"XL" 6	12	12	20	36	48	50	56	58	54
M - 22	18	12	24	30	44	44	52	60	52
T.R.	18	14	18	32	46	48	54	64	60
"XL" 7	18	10	22	30	48	48	56	62	54
M - 22	12	10	20	28	46	42	54	54	50
T.B.	18	6	20	24	42	36	50	56	54
"XL" 8	14	12	22	34	40	40	52	44	56
M - 26	18	14	20	28	40	46	50	54	56
M.D.	18	14	20	28	44	48	48	52	50
"XL" 9	20	18	24	26	44	56	48	52	56
M - 24	10	14	20	26	36	46	44	38	40
K.K.	16	16	20	24	36	40	46	42	38
"L" 10	14	12	20	28	36	40	42	44	42
MEAN	15.3	13.7	21.3	27.2	38.5	41.3	46.9	51.7	51.1
STANDARD DEVIATION	3.6	3.5	2.7	4.7	6.2	6.0	5.2	6.7	6.3

NRR= 16.6

PROTECTOR: HGU-84/P "OBJECTIVE REAL-EAR" DATES: 02/01/94 / 02/09/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 22	15	16	29	36	39	43	51	48	44
K.G.	12	14	27	36	40	41	46	48	43
"L" 1	10	13	25	31	36	35	45	46	41
M - 27	10	17	24	35	35	38	46	49	44
M.W.	8	15	25	32	33	37	44	47	40
"L" 2	10	15	27	31	26	37	46	45	42
M - 23	17	17	28	37	31	41	48	48	48
C.B.	17	18	27	36	32	38	41	45	45
"L" 3	15	17	27	31	29	38	42	41	47
M - 22	7	13	25	31	33	35	37	43	49
M.D.	8	15	26	32	32	35	40	42	44
"XL" 4	8	10	23	33	30	35	41	40	47
M - 23	13	16	24	37	40	41	42	46	45
S.Q.	14	15	25	37	40	40	41	47	48
"XL" 5	15	15	24	37	40	40	43	41	45
M - 24	13	16	20	37	44	45	50	53	51
J.P.	13	18	20	36	42	46	52	52	51
"XL" 6	11	15	22	36	42	45	51	50	47
M - 22	16	15	22	40	44	44	48	48	41
T.R.	14	14	22	39	42	47	49	49	41
"XL" 7	14	12	22	43	45	45	50	46	43
M - 22	11	14	23	39	40	44	49	49	41
T.B.	10	15	22	36	41	43	49	52	45
"XL" 8	11	14	21	37	41	45	50	50	42
M - 26	12	14	21	37	42	46	51	54	47
M.D.	13	15	22	38	41	45	50	54	50
"XL" 9	13	12	18	39	41	47	53	53	49
M - 24	13	15	26	36	38	37	42	45	40
K.K.	12	14	24	35	34	38	41	45	41
"L" 10	11	13	23	37	34	37	43	45	39
MEAN	12.2	14.7	23.8	35.9	37.6	40.9	46.0	47.4	44.7
STANDARD DEVIATION	2.6	1.8	2.6	2.9	5.1	4.0	4.3	3.9	3.5

NRR= 20.7

APPENDIX C

PROTECTOR: HGU-84/P (L) DATES: 03/01/94 / 03/07/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 23	15	12	22	38	37	44	45	41	41
M.D.	17	13	23	39	37	45	41	43	47
1	13	14	22	37	38	41	44	48	46
M - 22	16	17	23	37	33	39	48	46	42
J.B.	11	12	18	34	29	37	43	47	40
2	15	14	22	36	29	37	49	45	36
M - 27	13	13	19	31	33	41	44	44	46
M.W.	14	15	19	29	35	41	45	43	44
3	14	15	15	29	35	40	43	43	43
M - 23	18	15	22	38	43	45	51	45	42
E.F.	16	13	20	38	41	43	51	46	40
4	15	12	16	37	39	41	49	46	38
M - 22	17	12	21	28	36	45	50	42	44
C.M.	13	12	22	30	39	45	45	42	43
5	16	12	20	29	38	46	46	41	42
M - 23	17	12	22	34	28	35	38	42	41
J.T.	15	10	22	35	33	41	41	41	42
6	14	9	23	33	31	41	40	41	42
M - 27	13	12	21	34	38	45	46	49	41
T.D.	14	12	21	32	37	44	47	51	45
7	14	12	20	32	39	45	47	50	42
M - 26	19	13	22	38	44	45	52	41	38
M.D.	21	14	22	39	41	49	50	40	37
8	16	11	25	39	42	48	54	46	43
M - 24	18	15	22	40	34	44	49	51	44
G.A.	14	12	21	38	34	43	48	52	48
9	19	12	20	39	34	44	48	47	41
M - 25	18	13	22	38	39	53	52	51	47
M.M.	21	11	22	40	40	53	54	47	42
10	21	9	21	40	39	52	52	49	55
MEAN	15.9	12.6	21.0	35.4	36.5	43.7	47.1	45.3	42.7
STANDARD DEVIATION	2.6	1.8	2.1	3.8	4.1	4.4	4.2	3.6	3.7

NRR= 19.7

PROTECTOR: HGU-84/P (R) DATES: 03/01/94 / 03/07/94

SUBJECT	125	250	500	1K	2K	3.15K	4K	6.3K	8K
M - 23	14	14	24	39	36	39	49	46	44
M.D.	11	15	23	39	37	41	46	42	40
1	12	15	23	40	34	43	49	48	43
M - 22	14	15	24	33	35	40	41	43	45
J.B.	12	15	23	33	36	40	42	43	43
2	11	13	24	31	33	39	41	42	46
M - 27	14	15	24	39	37	43	47	41	44
M.W.	7	17	22	38	34	41	46	49	47
3	10	14	24	41	37	45	48	50	45
M - 23	15	15	26	34	39	38	39	37	43
E.F.	12	13	17	32	35	35	40	42	43
4	14	13	23	37	36	39	46	49	49
M - 22	14	15	22	29	31	34	39	44	38
C.M.	13	16	22	28	30	33	35	48	42
5	13	13	21	33	39	40	45	41	40
M - 23	16	13	25	38	32	41	43	44	44
J.T.	14	12	25	37	34	43	43	43	40
6	16	14	28	38	31	45	44	43	43
M - 27	10	14	20	33	35	38	44	51	45
T.D.	10	14	22	32	37	37	45	48	40
7	14	13	22	34	38	36	46	46	39
M - 26	16	15	22	37	39	43	48	42	35
M.D.	18	16	20	36	38	42	48	43	36
8	13	14	25	36	40	44	48	46	41
M - 24	18	14	26	39	39	42	44	43	39
G.A.	18	14	22	40	41	46	49	42	39
9	15	15	28	40	38	43	47	50	42
M - 25	14	12	26	37	37	45	48	44	42
M.M.	16	16	26	40	37	47	47	39	43
10	20	16	23	40	37	44	49	47	47
MEAN	13.8	14.3	23.4	36.1	36.1	40.9	44.9	44.5	42.2
STANDARD DEVIATION	2.8	1.2	2.4	3.6	2.8	3.6	3.6	3.5	3.2

NRR= 21.4

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	January 1995	

4. TITLE AND SUBTITLE
Sound Attenuation Evaluation of the Navy's HGU-84/P Helicopter Helmet

5. FUNDING NUMBERS
WRN62269/94/
WR00136

6. AUTHOR(S)
D. W. Maxwell and C. E. Williams

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Aerospace Medical Research Laboratory
51 Hovey Road
Pensacola FL 32508-1046

8. PERFORMING ORGANIZATION REPORT NUMBER
Technical Memorandum
95-1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Naval Air Warfare Center
Aircraft Division
Warminster, PA 18974-0591

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

"First article" sound attenuation tests were conducted on samples of the HGU-84/P helicopter helmet, candidate replacement for the SPH-3C series of helmets, supplied for evaluation by the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania. The tests were conducted in accordance with American National Standard ANSI S12.6-1984, "Method for the Measurement of Real-Ear Attenuation of Hearing Protectors." Objective measurements of attenuation, microphone-in-real-ear (MIRE), were also obtained for database and record purposes. Ten Marine Corps student aviators in the Naval Aviation Flight Training Program served as volunteer test subjects. Real-ear attenuation values calculated from measurements made at the nine, one-third octave test frequencies met or exceeded the required minimum real-ear attenuation specifications for the newly developed helmet. This technical memorandum documents the results of the sound attenuation tests. The HGU-84/P helmet is currently being fielded as a replacement for the SPH-3C helmet.

14. SUBJECT TERMS
Sound attenuation, Flight helmets, Real-ear attenuation

15. NUMBER OF PAGES
16

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR